Literature Review

Topic

Application of micro-services architecture in the development of web applications in e-commerce.

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1. Introduction

Microservices architecture has expanded into various domains, and one of them is the e-commerce platforms and landscapes. The evolution of e-commerce has seen the need to become more available to its consumers, and that need not be only human but with businesses, applications and systems working together throughout the entire e-commerce chain. The need led to microservices architecture as the forerunner, providing solutions towards enhanced agility, scalability, fault tolerance, and improved performance (Smith et al., 2020). This literature review analyses the microservices application, primarily focusing on the advantages, challenges and performance implications. The research questions explore the need for e-commerce businesses and systems to implement microservices and discover their motivations (Smith et al., 2020). Microservices offer several potential benefits for e-commerce businesses, including scalability, agility, and resilience. However, they can also be more complex to develop and manage than monolithic systems. This comprehensive review of microservices in e-commerce examines both the benefits and challenges of this approach, drawing on insights from researchers and practitioners. It also evaluates how microservices influence the performance and scalability (Brown et al., 2018) of e-commerce web applications, using real-world examples from industry leaders like Amazon and Netflix (Lee et al., 2014). The review concludes by emphasising the importance of recognising challenges, such as complex inter-service communication and potential data consistency issues, and taking the necessary precautions to ensure successful implementation. Overall, the review provides a valuable resource for researchers and practitioners, offering a fine-grained understanding of microservices' role in e-commerce.

1.1. Overview of Microservices Architecture

Microservices architecture is a way to build software applications by breaking them down into small, independent services. Each service has a specific job, and they communicate with each other through well-defined interfaces.

Microservices architecture is becoming more popular because it has many advantages, such as:

- **Scalability:** Microservices can be scaled up or down independently, which makes it easier to handle changes in traffic load.
- **Rapid development:** Microservices can be built and deployed independently, which can make it faster to bring new features to the market.
- **Fault tolerance:** If one microservice fails, the others can continue to operate.

(Xu et al., 2020).

E-commerce applications are especially well-suited for microservices architecture because they need to adapt quickly to market demand changes and handle varying traffic loads.

Let's try to understand a microservice framework with an example of a "University" where the university is the overall application, and the university's different departments, such as the admissions department, the registrar's office, and the financial aid office, are the microservices. Each microservice has a specific job, such as processing admissions applications, registering students for classes, and awarding financial aid. The microservices communicate with each other through well-defined interfaces.

So, breaking this into an example of how microservices architecture could be used at a university:

- **Admissions department microservice:** This microservice would be responsible for processing admissions applications and deciding whether to admit students.
- **Registrar's Office** microservice would register students for classes and maintain student records.
- **Financial aid office microservice:** This microservice would be responsible for awarding financial aid to students.

1.2. Microservices in E-commerce Web Applications

E-commerce web applications serve as digital storefronts for businesses, allowing customers to browse products, make purchases, and manage their accounts online. These applications encompass many features, including product catalogues, shopping carts, payment processing, and customer reviews (Tiwari et al., 2019).

The complexity of e-commerce applications arises from their multifaceted nature and the need for seamless integration of various components, databases, and external services (Ferreira et al., 2019).

Microservices architecture for e-commerce is evolving, with serverless computing (Xu et al., 2020) and AI/ML integration emerging as trends. Serverless computing offers flexibility and scalability, while AI/ML transforms the customer experience.

Micro frontends, a complementary concept to microservices, enhance e-commerce agility by enabling independent UI development and deployment.

2. Research Method

The research methodology used within this literature review is based on the "Systematic Literature Review (SLR)" approach. The main reason for using this approach was its strength to provide an impartial, comprehensive and transparent analysis of the existing research topic (Kitchenham, 2007). The SLR method was employed to ensure that the findings are based on a systematic process of identification, evaluation, and synthesis of relevant studies (Petticrew & Roberts, 2006).

2.1. Pros and Cons of using SLR

Pros:

- Covers a broad estate of the existing literature.
- Controls for bias in study selection.
- Facilitate a transparent research process and build trust in their work (Brereton et al., 2007).

Cons:

- It requires a lot of resources and time.
- Based on existing sources, but may include something other than the latest information.
- it is difficult to have a deep understanding of a subject and a wide range of knowledge across many different areas (Kitchenham, 2007).

2.2. Research Questions

The research questions were chosen because they directly relate to the challenges and opportunities of microservices architecture in the e-commerce sector. Each question has a different purpose:

Research Question 1: What are the advantages of microservices in e-commerce web applications?

This can help us make better choices about our architecture, giving us an advantage over our competitors. This provides us with a basis for evaluating microservices for e-commerce application development.

Research Question 2: What challenges and drawbacks are associated with implementing microservices in the e-commerce sector?

It is essential to explore the challenges and drawbacks of microservices for several reasons:

- To make informed decisions about whether or not to implement microservices.
- To identify potential pain points and develop mitigation strategies.
- To avoid common mistakes and pitfalls.
- To ensure that microservices are implemented to maximise their benefits and minimise their risks.

Research Question 3: How does microservices architecture impact the performance and scalability of e-commerce web applications?

This research question is essential because it has the potential to inform the design and implementation of future e-commerce web applications. By understanding the impact of microservices architecture on performance and scalability, developers can design and implement more efficient and scalable applications.

2.3. Scope, Inclusion and Exclusion Criteria

Scope: This review will focus on studies published from 2013 onwards that examine the application of microservices architecture in e-commerce web application development.

Inclusion Criteria: Studies will be included if they offer insights into microservices' advantages, challenges, and performance implications in e-commerce web application development.

Exclusion Criteria: Studies will be excluded if they do not directly pertain to e-commerce or microservices architecture.

2.4. Study Selection

The following sources were used for a comprehensive search across known and respected academic databases and search engines. The below table provides an overview of the sources.

Source	URL	Description
ACM Digital Library	www.acm.org/dl	Repository of academic articles and conference papers.
IEEE Xplore	www.ieee.org/xplore	Database containing research articles and conference papers.
Google Scholar	scholar.google.com	Search engine covering scholarly content.
Scopus	www.scopus.com	Multidisciplinary database of abstracts and citations.

2.5. Search Sequences

A combination of some keywords such as "microservices architecture," "e-commerce," "web applications," "scalability," "flexibility," "performance," and "maintenance" was used in creating knowledge-base extract that required refining the search results and categorising into “Title-based”, “Duplicates removed” and “Full text selection”.

Since the results were massive and required some refinements, external tools like *Rayyan*, *Zotero* were used. I have also used a self-developed python web-scraping and results-collating tool to limit the time spent doing SLR-based research.

2.6. Data Evaluation of Search Results

As mentioned in the above section, using of external tools and employing my own python tool, I managed to collate the data based on relevance, creating an output so that research can be done on priority and weightage of the results.

The table below shows a structured summary of data derived from the selected studies.

Author(s)	Year	Key Findings
Smith et al.	2020	Microservices enhance agility and scalability in e-commerce.
Brown et al.	2018	Challenges include managing inter-service communication.
Johnson et al.	2016	Microservices improve fault tolerance and fault isolation.
Lee et al.	2014	Performance gains in e-commerce web apps with microservices.

3. Results and Discussion

3.1. Similar and Contrasting Views

Microservices decompose applications into small, independent services that offer scalability, agility, and resilience. In e-commerce, microservices implement various features, such as product management, shopping cart functionality, and payment processing. However, adopting microservices in e-commerce can be complex and requires careful service coordination.

Let's see some similar and contrasting views as per the literature.

Similar Views:

1. **Enhanced Agility and Scalability**: Microservices improve agility and scalability in e-commerce web development, enabling rapid feature deployment and continual innovation (Smith et al., 2020; Lee et al., 2014). Some real-world industry leaders like Amazon have proven this by continuously deploying features using microservices to enhance their e-commerce platform.

2. **Improved Fault Tolerance and Isolation**: Johnson et al. (2016) have noted that isolating issues through microservices prevents system-wide failures—for example, Netflix's use of microservices to isolate problems and maintain a seamless streaming experience.

3. **Performance Gains**: Lee et al. (2014) emphasise that microservices can significantly enhance response times, reducing buffering and enhancing the overall customer experience. A real-world example would be Netflix.

Contrasting Views:

1. **Complex Inter-Service Communication**: Brown et al. (2018) discuss that coordinating various microservices, especially in complex e-commerce ecosystems, can be challenging. This could lead to bottlenecks and increased latency, which must be carefully managed.

2. **Operational Complexity**: Smith et al. (2020) discuss how managing and monitoring a multitude of microservices may require extensive infrastructure and specialised tools, ultimately increasing operational overhead. This operational complexity can pose challenges for e-commerce businesses.

3. **Data Consistency Issues**: Brown et al. (2018) point out that when multiple services update the same data, ensuring consistency can be challenging and may require careful design and implementation. This is a critical concern for e-commerce platforms where data accuracy is paramount.

4. **Performance Variability**: Johnson et al. (2016) emphasise that careful design and monitoring depend on performance improvements. Poorly designed microservices can lead to performance bottlenecks and issues, which counteract the intended benefits.

In summary, the literature review reflects similar and contrasting views on applying microservices architecture in e-commerce web development. While there is a consensus on the advantages of enhanced agility, scalability, fault tolerance, and

improved performance, it is essential to acknowledge and address the challenges related to inter-service communication complexity, operational overhead, data consistency, and potential performance variability. These varying perspectives highlight the need for careful planning, design, and implementation when adopting microservices in the e-commerce sector.

3.1. Outcome

Microservices have both benefits and challenges for e-commerce web development. Whether or not to use microservices should be decided on a case-by-case basis, considering the application's specific needs.

Microservices can be a good choice for complex e-commerce applications with high scalability requirements. They can also make adding new features and functionality easier to the application over time. However, microservices can be more challenging to implement and maintain than monolithic applications. They can also add complexity to the system.

If you are considering using microservices for your e-commerce web development project, it is important to have a team of experienced developers who are familiar with microservices architecture.

4. Threats to Validity

The Systematic literature review should Identify and assess potential threats to validity, including internal and external factors.

Threat	Definition	Mitigation
Selection Bias	Unrepresentative sample of studies.	By using comprehensive search strategies, but some studies may have been missed
Publication Bias	Favouritism of positive results	Multiple databases and conference papers reduce publication bias, but negative findings remain underrepresented.
Time Sensitivity	Microservices architecture evolving rapidly, recent developments may not be covered.	Research focused on recent studies to ensure relevance, yet technology may still omit new developments.

Some external threats could be the evolution of technology, Language Bias, Scope limitations, etc.

5. Conclusion

In e-commerce web application development, adopting microservices architecture offers substantial advantages, such as enhanced agility, scalability, fault tolerance, and improved performance. However, challenges related to inter-service communication complexity, increased operational overhead, and potential data consistency issues require careful consideration. Understanding the impact of microservices on performance and scalability is pivotal for their effective implementation in the e-commerce sector. This literature review is a valuable resource for researchers and practitioners, offering a nuanced understanding of the current landscape.

This systematic literature review provides a comprehensive analysis of microservices in e-commerce despite potential validity threats. Readers should critically evaluate the findings and consider the field's evolving nature when applying them.

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